

**GRIFFITH**  
**ON**  
**URINARY**  
**DEPOSITS.**

100,000





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A

## PRACTICAL MANUAL,

CONTAINING A

DESCRIPTION OF THE GENERAL, CHEMICAL  
AND MICROSCOPICAL

CHARACTERS OF THE BLOOD,

AND

SECRECTIONS OF THE HUMAN BODY,

AS WELL AS OF THEIR COMPONENTS,

INCLUDING BOTH THEIR HEALTHY AND DISEASED  
STATES; WITH THE BEST METHODS OF  
SEPARATING AND ESTIMATING THEIR INGREDIENTS;

ALSO,

A SUCCINCT ACCOUNT OF THE VARIOUS CONCRETIONS  
OCCASIONALLY FOUND IN THE BODY AND  
FORMING CALCULI.

BY

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&amp;c.

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TO  
GOLDING BIRD, A.M., M.D., F.L.S.,

ASSISTANT PHYSICIAN TO GUY'S HOSPITAL,

&c. &c.,

AS A SLIGHT TESTIMONY OF RESPECT

AND GRATITUDE

FROM HIS OBLIGED AND SINCERE FRIEND,

THE AUTHOR.





## PREFACE.

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THIS Manual is intended to assist the practitioner or student in medicine in discovering the deviations from health, and their nature in the blood and the various secretions of the body. An outline of the mode of analysing the different products, sufficient for practical purposes, is also subjoined, so as to make it a complete practical manual. The several branches of this subject have lately received a large share of attention, particularly from the German and French authors; and treatises somewhat analogous to this have appeared in those languages. The absence of such a one in this country has induced me to undertake the filling up of this deficiency. Much has also lately been done in the application of organic chemistry to the explanation of the phænomena of healthy and morbid actions. But I have avoided any notice of these views, as in many cases they are quite theoretical, and in the majority not well established. The use of the modern microscope is revealing to us the true structure of bodies in health, and their alterations in disease, with their true relations to their vital products, secretions. And as recourse to the microscope

often abbreviates chemical experiments, and enables us to ascertain the chemical nature of very minute portions of matter, I have added an account, with figures of the microscopical characters of each substance. In some cases, where I have not had opportunities, or at least insufficient ones, of testing their accuracy, or where I do not feel authorized in assenting to the correctness of their observations, I have borrowed the statements of former authors, and have given their names as authorities. Further information on these subjects and all their branches may be obtained from the writings of Becquerel, Berzelius, Bird, Christison, Liebig, Prout, Rayer, Rees, Simon, Turner, Vigla, Vogel, and Willis, to whom in some instances I am much indebted. I have also to acknowledge the kind assistance offered me on several occasions by W. Francis, Esq. It is to be wished that the facility I trust this Manual will afford those anxious to prosecute this most interesting branch of medical inquiry, in examining and appreciating morbid states of the various secretions, may enable us shortly to arrive at some more satisfactory conclusions respecting the pathological relations of these fluids.

9 St. John's Square,  
April 1843.

# PART I.

CONTAINING THE

GENERAL, CHEMICAL AND MICROSCOPICAL  
CHARACTERS OF

THE URINE AND ITS DEPOSITS,

BOTH IN HEALTH AND DISEASE,

AS ALSO THOSE OF

VESICAL CALCULI.



## INTRODUCTION.

TO those unaccustomed to chemico-microscopical examinations the following observations will save much trouble and vexation.

I. The specific gravity of urine is taken either by the Urinometer or the Specific Gravity bottle ; if the former be used we should bear in mind that its indications are never so correct as those of the bottle, although quite sufficiently so for ordinary purposes ; and moreover, those instruments sold at the shops should always be carefully tested as regards accuracy, by comparison with some standard instrument or the bottle.

II. In testing the acidity of urine use *thin* blue, and for alkalinity slightly reddened litmus paper. I have repeatedly seen urine considered neutral from neglect of attention to the former circumstance when it was decidedly acid.

III. Be sure your tests are pure, otherwise in operating on small quantities, you will be extremely puzzled at some of your results. The purity of your tests will be sufficient, provided they stand the ex-

amination required by the London Pharmacopœia. Oxalate of ammonia, not mentioned there, should be entirely dissipated by heat; and all that is precipitated from its solution by chloride of barium should dissolve in nitric acid.

IV. The best mode of microscopically examining urinary sediments is this:—Allow the urine to stand; decant the supernatant fluid; pour the remainder into a watch-glass; draw off the small quantity of fluid remaining after a short repose by means of a pipette, and then it can be conveniently viewed under the field of the microscope. In most cases an achromatic half-inch object-glass will be quite sufficient for the discernment and distinction of these deposits; but some few require one-eighth of an inch, as the pus and mucus globules, lithate of ammonia, and oxalate of lime. In urine, as is very frequently the case, where there is much lithate of ammonia mixed with the sediment, warm it gently in a watch-glass, then the supernatant liquid containing the lithate in solution can be removed by the pipette, and any insoluble sediment distinctly perceived. When we use the high powers of the microscope, we must not view sediments in a watch-glass, but, having obtained them moist in the watch-glass as above, pour this on to the middle of a glass slip, then drop a small square of thin glass over it; thus we have the object perfectly flat, the moisture is prevented from condensing on the object-glass, and there is no risk of scratching the latter.

V. It is often required for the sake of comparison to preserve these sediments this may be done either

moist or dry. Those only are preserved moist which are very transparent, as the oxalate of lime, globular lithate, pus, blood, &c.; the rest may be preserved in Canada balsam. Whenever you intend to preserve any deposit, be sure first to wash it well with distilled water, to free it from the gummy deliquescent matter with which it is combined in the urine. If to be preserved in balsam, allow it to dry on a glass slide; then hold some Canada balsam on the end of a stick over a spirit-lamp at some distance from the flame\*, so that it shall gently melt; just as it has melted and is on the point of dropping from the stick, hold under it the previously gently warmed glass slip lying on which is the deposit; in this manner so much of the balsam may be dropped on the glass as is sufficient to cover the deposit: while it is still warm, drop on the surface of the balsam a slip of thin glass, also previously warmed, press this gently, allow the whole to become hard, and the specimen is permanently preserved. All the objects for examination by polarized light are beautifully prepared in this manner. Those to be kept moist, are washed carefully, placed on a glass slip, and a drop or two of weak spirit, water saturated with creasote, or Godby's fluid†, used without heat in the same manner as the balsam. As soon as all the fluid not confined between the two glasses has been carefully

\* If this be not attended to bubbles will be formed and the specimen spoiled.

† This is composed of bay-salt, one ounce; alum, half an ounce; corrosive sublimate, one grain; distilled water, half a pint.

wiped away, surround the thin glass at its edges with gold size thickened with lamp-black (this may be dropped around the edges of the glass with the end of a pen), and allow it to dry; thus we have the specimen permanently preserved in a cell. Some objects require to be preserved in syrup; a strong syrup should be made mixed with a little gum, this should be kept for some time, and then used without heat in the same way as the balsam. Salts and pus, with other organic globules occasionally present, may be well preserved in this way.

VI. I shall now give an abstract account of the ordinary modes of procedure in the analytical examination of the urine, the minute details will be found in other parts of this work. When we wish to examine any specimen of urine, it is very important that some of its characters should be ascertained as soon as possible after it is passed; this is particularly the case with those specimens which contain excess of urea or mucus, as alkalinity occurs so soon in some of these cases, in the secretion which is acid at the time it is passed, as to be without care a source of error. Those containing excess of acid keep better. The first point then is to note its acidity (II.). The amount may be estimated by neutralizing the free acid by a dilute solution of ammonia, the quantity of the solution required, and whose strength is previously known, will indicate the proportion of acid. We now set it aside and allow the sedimentary portions to subside. Then having noticed the apparent characters of the sediment, pour off the upper clear portions (should the upper part not be clear it can be



filtered). We next notice the colour of the urine, and also take its specific gravity.  $\alpha$ . The sedimentary portion must be examined microscopically (*vide* IV.) and then chemically. We have now obtained some idea of its constituents; the peculiar appearances of the organized portions can be compared with the figures in the Plates (Pl. I. and II.), and if there be any doubt about their composition, they can be examined chemically.  $\beta$ . Should the sp. gr. of the urine be above or about 1030, we may *suspect* the presence of either sugar or excess of urea. The former may be ascertained by setting aside a portion, in a warm place; the production of the peculiar vegetable organizations, forming the white powdery surface, will readily decide this question (33.). The excess of urea may be also readily detected (11.). Should its sp. gr. be low, if the colour is pale and the urine clear, most probably the quantity is increased, and the solid contents diminished; if it be not clear but muddy and dull, albumen may be suspected, the presence of which is readily detected by ascertaining that the urine is acid and then boiling (19.). In all cases where we are about to analyse the urine quantitatively, a small portion should be examined previously, so that we may become acquainted with the predominating ingredients. Should the urine contain much mucus, this may be thrown down by acetic acid or alcohol; by its being thus coagulated the fluid portion passes readily through the filter. In ordinary cases of filtration, where the fluid is not loaded with insoluble portions, we may use filters whose weight is previously known, and

the residue after combustion is very minute, and also previously known.

Supposing then we have disposed of the deposits, and the filtered liquor is clear, if it contain albumen this is first estimated by boiling a proper quantity. The albumen thus coagulated is collected on a filter, washed (the washings must be added to the filtered liquor), and dried in a water-bath. The weight of the dried albumen, *minus* the weight of the filter, gives us the absolute quantity of the former which the boiled portion of the urine contained. When we require to be very accurate, or operate on very small quantities, the albumen must be boiled in alcohol or æther previous to desiccation, so as to separate fatty matter. The filtered albuminous liquor, as well as the washings, or when no albumen is present, the original liquid is evaporated to dryness on the water-bath; the weight of the residue + the weight of the albumen when present is the amount of solid constituents. Should this residue contain any fatty matter, this can be separated by boiling æther; the weight of this æthereal extract + that obtained from the albumen gives us the whole amount of fatty matter. Sometimes the æther dissolves, besides fat, other matters, as salts, &c.; these are separated by washing with water. The extract which has been treated with æther is then acted upon by alcohol, sp. gr. .830; this dissolves the urea, colouring matter, sugar (when present), alcoholic extract, metallic chlorides (sodium, potassium), and sal-ammoniac, with the lactates. The filtered solution, together with the alcohol used for washing, is then

evaporated to dryness. The weight of the residue gives the weight of all the above-named compounds.

*a.* The urea is estimated by adding nitric or oxalic acid to its concentrated solution. *β.* If sugar be present, this is either allowed to crystallize, or its quantity is estimated by fermentation (33.).

*γ.* The fixed salts are estimated in quantity by incinerating the extract; the ash contains chloride of sodium, chloride of potassium as such, and the lactic salts with fixed bases as carbonates (14.). The sal-ammoniac and volatile lactates have disappeared. The separation of those organic matters soluble in alcohol from those insoluble in that liquid is not ordinarily necessary, the mode recommended in (14.) is sufficiently accurate.

Another mode is, using a separate portion to calculate the urea (this portion ought to be more considerable than the one we are about to mention; the latter may be very small, provided we have a delicate balance). Evaporate, weigh, digest with alcohol, (·830), and filter; lithic acid and the phosphates remain as a residue (these can be readily separated by the solubility of the former in liquor potassæ). The alcoholic solution is evaporated, dissolved in a considerable quantity of water, and boiled with caustic lime, until the urea is completely decomposed. The lime is precipitated by oxalic acid; the extract contains lactic acid, lactates, muriate of ammonia, and alcoholic extract, whose amount can be estimated by the filtration and evaporation of the liquid.

VII. The evaporations in all these cases should be performed in a steam-bath, or in some cases a water-

bath may be used, but a high temperature should be carefully avoided.

VIII. All incinerations should be performed in a porcelain or platinum capsule; and whenever any liquid is to be filtered, the filter must be previously moistened with distilled water.

IX. All reactions in which colour is produced are best observed in white, earthenware, glazed, evaporating dishes or capsules.

X. A freezing mixture is readily made either by mixing powdered nitrate of ammonia and water in equal weights; or equal parts of nitre and sal-ammoniac powdered and added to four parts of water; or pounded ice and common salt.

Having now given what will be sufficient on the general methods of examination, I will proceed to minuter details.

# GENERAL, CHEMICAL

AND

## MICROSCOPICAL CHARACTERS

### OF THE URINE, &c.

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1. THE function of the kidneys is to separate from the blood by their selecting power certain compounds which are of no further use in the animal economy, and the retention of which in the blood acts as a virulent poison to the system. These compounds dissolved in water and forming the urine are very numerous, and of very different natures; some undoubtedly exist in the blood, whilst the detection of others eludes our strictest chemical investigations, consequently we must believe that they do not exist in that fluid.

2. The quantity of urine passed daily varies greatly according to circumstances. In health the most important of these is the state of the skin; the state of the liver is also intimately associated with that of the kidney, and consequently of the urine. The normal quantity may be considered as between 30 and 40 ounces. The amount will be diminished if the se-

cretion of the skin be much increased by active exercise, warmth, or sweating from any cause; and much increased if the functions of the skin be impeded or suspended; in cold atmospheres, after copious draughts of fluid, &c.

3. The odour when first passed is somewhat aromatic, but this disappears on cooling, when it is replaced by one peculiar to that fluid.

4. Urine is always acid in health; this acidity most probably depends upon the presence of acid salts. It does not, as was supposed, contain any super-salts of lime\*.

5. Its specific gravity varies greatly in health, and is in an inverse ratio to its quantity. It may be said to vary from 1015 to 1025; the average throughout the day would be rather less than 1020. If the specific gravity be higher, an increased amount of solids need not be necessarily inferred†, because the quantity of the fluid may be diminished; nor if the sp. gr. be much diminished, is a diminution of solids passed a necessary consequence, because the amount of the fluid may be increased; so that in estimating the value of the sp. gr. we must pay particular attention to the quantity. Three varieties of urine may be distinguished,—1st, that passed after drink, and which is exceedingly low in sp. gr., *Urina Potûs*; 2nd, that which occurs after the completion of digestion, *Urina Chyli*, this is usually of the highest sp. gr. of any; 3rd, that which is passed in the morning, and

\* Thomson, Animal Chemistry, 1843.

† I allude to the quantity per diem, not the absolute quantity under examination.

is secreted from the blood, consequently not immediately affected by ingesta; this is the *Urina Sanguinis*. This may be considered as the pure renal secretion, and is that which should generally be examined as indicating the state of the system.

6. The quantity of solid materials passed during the 24 hours varies according to the sp. gr.; it is on an average, in health,  $2\frac{1}{2}$  oz.\* : the amount in any specimen of urine whose sp. gr. is known may be found out by reference to the following table†:—

Sp. gr. at 50° F.	Solids‡.	Sp. gr. at 50° F.	Solids.
1001	1·65	1016	26·40
1002	3·30	1017	28·05
1003	4·95	1018	29·70
1004	6·60	1019	31·35
1005	8·25	1020	33·00
1006	9·90	1021	34·65
1007	11·53	1022	36·30
1008	13·20	1023	37·95
1009	14·85	1024	39·60
1010	16·50	1025	41·25
1011	18·15	1026	42·90
1012	19·80	1027	44·55
1013	21·45	1028	46·20
1014	23·10	1029	47·85
1015	24·75	1030	49·50

7. Urine is generally of an amber tint. The colouring matter varies much in its intensity, but it cannot be separated in a state of purity. The brown organic matter which gives the colour to inspissated urine and seems to be the source of its peculiar odour, has recently been examined, and has yielded a brown, fusible, resinous mass, having a strong

\* Christison.

† Becquerel.

‡ In 1000 parts.



odour of castoreum when dry, and a urinous smell when boiled with water\*. The colouring matter is usually much increased in quantity when excess of lithic acid is present. Dr. Prout considers that there are two colouring principles in urine which are intimately related to each other, and which by their properties seem to indicate that they are related to lithic acid on the one hand, and some modification of that of the bile on the other. The colouring matter of the bile resembles lithic acid in assuming a purple tint by nitric acid. Polarized light when transmitted through healthy urine does not, when analysed, develop any colour, nor is any notable change produced.

8. When healthy urine is first passed it is not quite transparent, but by repose it becomes so, and a very delicate cloud falls to the bottom of the containing vessel; this is mucus mixed with a few epithelial scales. Some have denied that there is any deposit in healthy urine, but by careful examination this is found invariably present. It may be collected by filtering the urine, when it remains on the filter as a transparent colourless mass, of a shining appearance when dry.

*Chem. prop.*—It is readily soluble in nitric and acetic acids† and in liquor potassæ; the acid solutions are precipitated by solution of ferrocyanide of potassium. It is not coagulated by boiling. It is insoluble in sulphuric acid. It contains albumen in some

\* Scharling.

† When the secretion of mucus is much increased it is only partially soluble in acetic acid.



unknown state of combination, as it is not coagulated by boiling or nitric acid, although it is precipitated by galvanic electricity and ferrocyanide of potassium.

Mucus often exists in great excess in urine. In mild cases the ordinary mucous cloud is merely increased in quantity and retains the same appearance, except that upon careful examination we find very delicate opake threads floating in it; these are composed almost entirely of the peculiar globules. When however it is more abundant it becomes much firmer, and often forms large gelatinous stringy masses, which can be drawn out in ropes. When present it soon causes the urine to putrefy. It does not render it coagulable by heat, although often so by acetic acid; moreover it does not give evidences of free albumen. The presence of mucus in the urine acts as a ferment, for after its separation it may be preserved a much longer time without decomposition.

*Microscop. characters.*—It is almost entirely composed of amorphous, extremely minute granular particles; sometimes we have one or two mucous globules similar to those of pus, and here and there an epithelial scale or two, but it is nearly all amorphous.

9. There is another deposit which often exists in urine and is quite consistent with health: this is the lithate of ammonia. When healthy urine is placed under the receiver of an air-pump with sulphuric acid, and the atmospheric pressure is removed, a copious amorphous precipitate of this substance occurs; also when the quantity of urine is much diminished and the temperature reduced, this

compound falls. It may be readily known from all others by its solubility by boiling in water or urine, and its entire dissipation at a red heat; but for its minute characters *vide* (15.).

I. Having thus noticed the general properties of the healthy secretion and its deposits, we will now examine its chemical constituents in health, with the means of separating and estimating them\*.

10. The quantitative analyses of the urine which have been made are comparatively few, and that of Berzelius, which was made many years ago and has appeared in every work relating to the subject since, is almost the only published one which has been minutely carried out. But for practical purposes they are not required to be carried to the extent adopted by that illustrious chemist. The following may be taken as a type of what is quite sufficient for ordinary practical purposes:—

1. Water . . . . .	972.	} = 1000 grs.
2. Urea . . . . .	12.	
3. Lithic acid . . . . .	0.398	
4. Fixed salts . . . . .	6.918	
5. Ammoniacal salts and organic matters }	8.6†	

The fixed salts are chloride of sodium, sulphates of soda and potash, phosphate of soda, magnesia and lime: thus—

\* An excess of these constituting disease is noticed under each head.

† Becquerel.

Chlorine . . . . .	0.502
Sulphuric acid . . . . .	0.855
Phosphoric acid . . . . .	0.317
Soda . . . . .	} 5.244
Lime . . . . .	
Magnesia. . . . .	
Potash . . . . .	
	<hr/>
	6.918

The organic matters and ammoniacal salts are lactic acid, lactate of ammonia, osmazone, animal extractive soluble in water only, muriate and phosphate of ammonia.

11. UREA.—This ingredient enters most largely into the composition of the urine, and to it many of its most important properties are due. It is supposed to be generated in the human body during the destructive assimilation of the gelatinous tissues. It is formed in the blood, and the presence of the kidney is not necessary to its formation.

*Chem. prop.*—When pure it is perfectly colourless; neither acid nor alkaline; crystallizes in the form of very delicate and silky four-sided prisms. It combines with, but does not neutralize acids. It is soluble in its own weight of cold water and in every proportion of hot; in  $4\frac{1}{2}$  parts of cold and 2 of boiling alcohol, and it separates from the hot alcoholic solution on cooling. It is almost insoluble in sulphuric æther, forms crystalline compounds with nitric and oxalic acids, and is entirely dissipated by heat. It is composed of  $C^2 O^2 H^4 N^2$ . It is one of the few organic compounds which can be artificially

prepared, and can be obtained thus\* :—Mix 28 parts of dry ferrocyanide of potassium with 14 of peroxide of manganese in powder, and make the mixture as intimate as possible. Heat this on an iron plate over a charcoal fire to a dull red heat ; it must be well stirred while cooling. When cold digest it repeatedly in cold water, and mix the solution with  $20\frac{1}{2}$  parts of sulphate of ammonia. The first concentrated liquid obtained by washing the residuum should be set aside, and the sulphate of ammonia dissolved in the succeeding weak liquids. A copious precipitate of sulphate of potash falls. The supernatant liquor is decanted off and evaporated over the water-bath. More sulphate of potash falls, which is separated, and this is repeated as long as the sulphate continues to form. The liquid is now evaporated to dryness, and the solid residue is digested in boiling alcohol of 80 or 90 per cent. The urea is dissolved. It crystallizes as the solution cools or is evaporated†.

A concentrated aqueous solution of urea is not precipitated by nitrate of silver, bichloride of mercury, alcohol, infusion of galls, nor alkalies.

By the aid of the microscope we may ascertain the presence of a very minute proportion of urea. Evaporate its aqueous or alcoholic solution ; then add a little nitric or oxalic acid ; delicate silky crystals

\* Although the description of such details as those necessary for the preparation of urea may appear contrary to what is expected in a practical manual, the artificial production of this compound is so highly interesting, and the process so readily conducted, that I am sure it will not be out of place here.

† Liebig and Wöhler.

of nitrate or oxalate of urea occur. This evaporation should be performed on a glass slide, and the subsequent crystallization examined by the microscope.

The state of combination in which urea exists in the urine is not satisfactorily ascertained. MM. Cap and Henry stated that it existed combined with lactic acid; but others, on repeating their experiments, instead of obtaining lactate of urea, have obtained the urea pure, which most probably Cap and Henry have mistaken for the lactate\*. Moreover, M. Pelouze has proved that no such compound as lactate of urea exists.

Its strong aqueous solution is not decomposed by ebullition, whilst the diluted solution decomposes very rapidly, and is converted into carbonate of ammonia†. As it is so very soluble and readily decomposed, we generally estimate it in combination with nitric or oxalic acid. Its impure crystals can be best decolorized by a little permanganate of potash‡, which destroys the colouring matter and has little action upon urea; an excess of the salt is removed by alcohol, which converts it into peroxide of manganese. It often exists in excess, sometimes with increase in the quantity of the urine, when that

\* Turner's Chemistry by Liebig and Gregory; and Chemical Gazette, No. 3, December 1842.

† M. Vogel found that the relative proportion of urea was not diminished in urine by keeping for six weeks, nor by boiling for three hours and a half, but this is certainly not commonly the case.—*Anleitung zum Gebrauch des Mikroskopes*, Leipzig, 1841.

‡ Turner's Chemistry by Liebig and Gregory.

fluid is pale; it is always in excess when the quantity of urine is diminished and its sp. gr. high, and in combination with excess of lithic acid and the lithates.

*a.* When an equal volume of nitric acid is added to a portion of urine in a watch-glass, if there be no excess of urea present no crystallization takes place; but if there be excess, a brownish-yellow crystalline\* compound is formed; this is the nitrate of urea. Its appearance is preceded by the formation of some bubbles, and in acid urine these bubbles are generally more numerous the larger the quantity of urea present, so that its presence in excess may generally be foretold. Its crystallization sometimes takes place in a few minutes, sometimes it requires a lapse of several hours. This is a very rough method of detecting an excess of urea, and in making use of it we must carefully notice the temperature, because the higher this is, the less likely will the crystallization be to take place, and *vice versa*.

*b.* To estimate its quantity more accurately proceed thus:—I. Evaporate the urine to dryness over a steam-bath; moisten this extract with water, and pour strong alcohol on it. Evaporate this to dryness with a very low heat; dissolve it in a small quantity of water, and add nitric acid; then place the compound in ice or a freezing mixture. Throw it then on a filter, and wash it with ice-cold water, gently press and dry it. By then subtracting the previously

\* These crystals appear when perfect as rhomboidal tables, sometimes having the angles truncated. (*Vide* Pl. II. figs. 37 and 38.)

known weight of the filter from that of the dried filter containing the nitrate of urea, we ascertain the amount of the latter, and on subtracting the proportional of nitric acid from this, we obtain the weight of the urea present.

Nitrate of urea is composed of 52.63 nitric acid + 47.37 urea in 100 parts.

II. Evaporate a given weight of urine over the open steam-bath to dryness; boil successive portions of alcohol on the dry residue until nothing more is taken up; mix the liquors; evaporate to the consistence of an extract; redissolve in a small quantity of lukewarm water; add oxalic acid to this solution until no more becomes dissolved on heating the liquid to 122° F. Allow the liquor to cool; a crystalline deposit of oxalate of urea occurs; collect this on a filter, and wash it with a small quantity of weak solution of oxalic acid. This last, as well as the mother-liquor, must be evaporated to procure any crystals which may exist in them; the crystals must then be dried in bibulous paper; then redissolve them in water, and neutralise the oxalic acid with carbonate of lime; filter and well wash the precipitate. Evaporate the filtered liquors and the washings over the open steam-bath, and weigh the extract\*. This should be entirely soluble in anhydrous alcohol; if not, the weight of the residue must be deducted from that of the extract; we thus get the weight of the urea. Or we may calculate the amount of urea by

\* These evaporations must not be hurried; if they are, no dependence can be placed upon the results.



deducing its weight from that of the undecomposed oxalate, which is in general the best mode.

Oxalate of urea is composed of oxalic acid 37·436

... .. urea . . . . 62·564

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100·00\*

III. Or nitric acid may be used instead of the oxalic, and the nitrate of urea decomposed by carbonate of baryta, instead of carbonate of lime.

*c.* To extract the urea in diabetic urine:—Expose a given quantity of urine, mixed with some yeast, to the temperature of 80°, in a graduated glass jar inverted over a mercurial bath; we thus get rid of the sugar by fermentation, and can proceed as below (*d*): the quantity of sugar present is also indicated at the same time (33.).

*d* To estimate the urea in albuminous urine:—Evaporate the urine to dryness in an open steam-bath, treat the residue with boiling alcohol. Evaporate the alcoholic solution and redissolve the extract in distilled water; concentrate this to a syrup, then mix it with half its bulk of pure nitric acid. Place it in a freezing-mixture: the crystallized nitrate is then produced. The supernatant liquid is then poured off, the crystals washed with ice-cold water and dried in the open steam-bath. We may then calculate the amount of urea by abstracting the equivalent of nitric acid from the weight of the crystalline nitrate.

*e.* For the peculiar effect of the presence of urea in

\* Berzelius.



altering the ordinary form of the crystals of chloride of sodium, see (13.).

12. LITHIC ACID exists in the urine combined with ammonia. This compound is deposited from healthy urine under certain circumstances (9.).

*a. Chem. characters.*—It is soluble in 10,000 parts of cold water, the solution feebly reddens litmus. When pure it is white, but is always coloured when existing as a urinary deposit; insoluble in alcohol and æther; soluble in liquor potassæ and strong sulphuric acid, from the latter of which it is precipitated by water; sparingly soluble in the alkaline carbonates\*; rather more soluble in strong hydrochloric acid than in water; soluble in both diluted and strong nitric acid, equal volumes of gaseous carbonic acid and nitrogen being given off. After evaporating the nitric solution a red extract is left, which becomes of a beautiful purple by the addition of ammonia. This is the purpurate of ammonia, purpurine, or murexide, and is the characteristic of the presence of this acid. Murexide is but slightly soluble in cold water, but colours it of a fine purple; it dissolves in water at  $158^{\circ}$ , and crystallizes on cooling; it is insoluble in alcohol and æther. Urea is formed by the distillation of lithic acid. The crystals of lithic acid are of a yellowish-brown colour; the colouring matter is related to that of the bile, as, like it, it becomes of a purple colour by the action of nitric acid. The composition of lithic acid is  $C_{10} N_4 H_4 O_6$ .

*b. Microscop. characters.*—It is always crystalline. As occurring in urine the crystals are always coloured.

\* Lithic acid is most soluble in carbonate of lithia (1 to 4).

Their varieties of form are almost endless ; the most common only will be noticed. The crystals are either separate or combined into clusters. When separate, the outlines are either rhomboidal, square, or rectangular, and all their varieties appear to me to be clearly explained by assuming them as derived from the right rhombic prism. The most perfect and the largest crystals generally approach nearest to this form. In many cases this prism is very much flattened, so as without great care to be mistaken for a rectangular plate. A cube of lithic acid I have never seen, although I have sometimes been shown what was considered one, *i. e.* a crystal with a square surface ; the other surfaces were not seen in these cases, but only imagined. In many cases we find the prisms of tolerable length, as in Pl. I. fig. 1 ; of course here the rectangular outline of the crystal, as it lies on its side, is very distinct (but by moistening any specimens we are examining with water, and then adding a little æther or spirit, currents are produced which cause the crystals to turn over continually and in every direction, so that a full view of every surface is obtained). In other cases the prisms are extremely short, so as to lie upon one of their flat extremities ; here of course the rhomboidal base only is seen, as in Pl. I. fig. 2. In many cases, especially where the acid has been precipitated by the addition of muriatic or nitric acid, the crystals possess a curious hour-glass internal structure ; the relations of this are difficult to comprehend. In some cases the two obtuse angles of the rhombic prism are replaced by two semicircular facets, as in Pl. I.

figs. 3 and 4. A very curious modification of form is seen in the lithic acid obtained from the guano, or the excrement of serpents ; in these we find the crystals are extremely thin, possess the hour-glass internal structure, and are apparently nothing more than delicate tables ; but by viewing them when turning over, we can distinctly see that they are the same rhombic prisms very much flattened. In many cases, where the containing urine has been very acid, the crystals are striated, as in Pl. I. fig. 13  $\beta$  ; but in others we find this without any such acidity. The aigrettes and other combinations we so frequently meet with seem irregularly or more hurriedly formed, although sometimes we find them in the urine mixed with the ordinary rhomboids (see Pl. I. figs. 9 and 12). When we add a few drops of any acid to urine the lithate of ammonia contained in it is decomposed ; the acid added appropriating the ammonia, whilst the lithic acid falls in crystals (Pl. I. fig. 1). This is the ordinary mode of ascertaining the amount of lithic acid present in urine ; for this purpose use muriatic or acetic acid, as nitric acid dissolves the lithic acid.

c. Urine containing a deposit of lithic acid is generally minus\* its proper quantity in solution ; some acid furnished by the system decomposing the lithate of ammonia in its passage to the bladder. This is sometimes lactic acid, sometimes phosphoric, and sometimes sulphuric.

\* In the majority of cases of lithic acid gravel the amount of that compound deposited very much exceeds that ever naturally contained in the urine.

The crystals of lithic acid, when examined by polarized light, develop splendid colours; the pure do so beautifully. This is sufficient to show that cubes of this substance cannot exist, inasmuch as it does not belong to the cubic system.

*d.* Calculi composed of lithic acid are generally smooth, or having broadish tubercles; of a brownish-yellow colour, with their layers concentrically arranged; and are readily distinguished by their entire volatility by heat\*; insolubility in water; formation of murexide with nitric acid and subsequent evaporation; solubility in liquor potassæ; and reprecipitation in a pure crystallized state by the subsequent addition of an acid.

13. The fixed salts are chloride of sodium, sulphates of soda and potash, phosphate of soda, magnesia and lime. For ordinary purposes these may be estimated together; they constitute the residue of the incineration of the extract arising from the evaporation of any given weight of urine. They are composed of salts soluble and those insoluble in water. The former are alkaline, the latter earthy salts. A portion of silica has usually been considered as present in urine, but the quantity is so minute, if really existing in health, that it is not worth noticing; it would remain in combination with the earthy phosphates. Should you require to separate the alkaline salts proceed thus:—Divide their solution in water into two parts; acidulate one of these with nitric

\* There is usually a small quantity of a calcareous residue, but this is foreign to the composition of the lithic acid.

acid; then precipitate the contained sulphuric acid by nitrate of baryta; the sulphate of baryta falls as a white precipitate\* (the other salts of baryta would be dissolved by the nitric acid should they form in the solution); this is collected on a filter, washed, and dried; it is then weighed, and by deducting the weight of the baryta, we obtain that of the sulphuric acid with which it was combined. (*Vide* Table.)

If the filtered liquor and washings, which are acidulous from the excess of nitric acid added, be saturated with ammonia, a precipitate of phosphate of baryta† falls; this must be collected and dried on a filter; by abstracting the weight of the baryta we obtain the weight of the phosphoric acid. (*Vide* Table.)

The second portion is used to determine the quantity of muriatic acid present. Acidulate this with nitric acid. (This dissolves the phosphate of silver or the sulphate, should any be formed.) On the addition of solution of nitrate of silver, an insoluble curdy chloride is formed‡, which must be collected on a filter, well washed, and then fused. From the weight of this we abstract the weight of the silver, when we obtain the weight of chlorine present. (*Vide* Table.)

To ascertain the weight of the bases we must add the correct proportions requisite for neutral combination. The sulphuric acid must be divided between potash and soda; the phosphoric and muriatic acids are in combination with soda only.

\* Amorphous and granular.

† *Idem.*

‡ *Idem.*

Table showing the composition of the various salts mentioned above\*.

Phosphate of baryta...	Baryta	68·20	+	acid	31·80	=	100
Sulphate of baryta.....	Baryta	65·63	+	acid	34·37	=	100
Sulphate of potash.....	Potash	54·07	+	acid	45·93	=	100
Chloride of silver .....	Silver	75·33	+	acid	24·67	=	100
Chloride of sodium ....	Sodium	39·66	+	acid	60·34	=	100
Phosphate of soda.....	Soda	46·70	+	acid	59·30	=	100
Sulphate of soda.....	Soda	43·82	+	acid	56·18	=	100†

Common salt ordinarily crystallizes in eubes ; a peculiar structure is apparent in many of these crystals which gives very much the appearance of octahedra (Pl. II. fig. 28). When common salt is slowly evaporated from its solution in urine it crystallizes in octahedra, tetrahedra, and in irregular hexagonal plates, &c. (Pl. II. fig. 29). These latter might be confounded with cystine ; but they are readily soluble in water, which cystine is not ; and they are not destroyed by a red heat, which cystine is ; moreover, we rarely or never see an equilateral hexagonal plate as in cystine. The effect of polarized light would in some instances assist us.

When common salt is crystallized rapidly by evaporation from a solution containing urea, delicate foliaceous crystals are produced, among which the form of the dagger is predominant. This has been proposed as a test of the presence of urea, and may perhaps in some cases be useful (Pl. II. figs. 30 and 31).

The presence of soda in any residue of ineinera-

\* In the anhydrous state.

† Berzelius.



tion is readily indicated by the blowpipe\*. The ash is moistened with distilled water, and placed in a loop or small coil of platinum wire; by directing the point of the inner flame against this, the outer flame becomes tinged intensely yellow.

Potash is recognized by its concentrated watery solution being precipitated by an excess of tartaric acid, forming a crystalline bitartrate. When examined by the microscope this appears in the form of rhomboidal colourless tables†, sometimes perfect, but ordinarily with truncation of the acute angles; or a spirituous solution of chloride of platinum gives a yellow precipitate, which appears under the microscope composed of aggregations of small prismatic crystals‡. Both these reagents however give certain evidences of the presence of potash only when the substances suspected to contain it are incinerated; for concentrated ammoniacal solutions produce similar precipitates with these reagents. By the blowpipe the salts of potash yield a violet tinge to the flame.

The mode of separating the magnesia and lime in the earthy phosphates is this:—Dissolve in dilute hydrochloric acid, nearly neutralize by ammonia, warm gently, and then add slight excess of oxalate of ammonia; an insoluble precipitate of oxalate of lime falls; this appears under the microscope either in

\* The antimonite and antimoniate of potassa have been recommended as tests for soda, forming a white crystalline precipitate in its solutions; no free acid must be present.

† Vogel. I have always obtained the bitartrate from urine in the prismatic, not tabular form.

‡ *Id.* These have appeared to me as very minute octahedra.

amorphous granular masses of a dull colour, or when the formation is slower, small brilliant octahedral crystals (Pl. II. fig. 26). The subsequent addition of ammonia precipitates the phosphate of magnesia\*. This assumes the form given in Pl. I. fig. 18. If we wish to obtain the amount of sulphuric acid present in any product we are examining, it may be done by acidulating as above with nitric acid, and the subsequent addition of nitrate of baryta. The amount of phosphoric acid may be estimated in the residue of earthy phosphates, by dissolving these in dilute nitric acid†, nearly neutralizing by ammonia, and then adding solution of nitrate of silver, when the yellow phosphate is precipitated. This phosphate of silver is composed of 82.99 parts of oxide of silver + 17.01 parts of phosphoric acid in 100.

14. The LACTATES, AMMONIACAL SALTS, and organic matter with them cannot be completely separated; and for practical purposes they are best estimated together. There is most probably free lactic acid in the healthy urine. We obtain the weight of these matters in an analysis thus:—Evaporate a

\* Or the following method, which is perhaps better, may be used:—Dissolve the two in hydrochloric acid; then add to the solution, first, sulphuric acid, and then sufficient alcohol to form a weak spirituous solution. The sulphate of lime falls as a precipitate; this is washed with diluted alcohol, and separated by filtration; then drive the alcohol off in vapour by a continued gentle heat, after which precipitate the phosphate of magnesia, in the bibasic form, by ammonia.

† Acetic acid may be used, but on no account muriatic acid, as this would form an insoluble white chloride, which would quite obscure the yellow phosphate.



given weight of urine over the steam-bath to dryness, weigh the residue. Then incinerate and decarbonize this residue; again weigh; we then know the weight of the destructible portions of the extract; if from this we extract the weight of the urea and lithic acid we shall have the desired weight.

The state in which lactic acid exists in the urine is uncertain. It is soluble in water and alcohol, as are most of its salts. No precipitate is occasioned in its solution, or in that of its salts, by acids or alkalis. Neither lactic acid nor its salts, which occur in the body with alkaline bases, are precipitated by chloride of calcium, chloride of barium, nitrate of silver (although the latter solution becomes troubled after some time in consequence of the silver being reduced), nor by bichloride of mercury. When chloride of iron is added to a solution of a neutral lactate, or to lactic acid saturated by ammonia, the solution does not assume a blood-red colour, nor is oxide of iron immediately precipitated by an excess of ammonia; but after some time a turbidity and gradually a precipitate of oxide of iron falls\*. In very dilute solutions of lactic acid this occurs immediately. When lactates with fixed bases are heated to redness, the base remains in the ash as a carbonate.

Composition,  $C_6 H_5 O_5 + aq.$

In the ordinary state lactic acid occurs as a deliquescent liquid, but by sublimation it may be obtained in crystalline rhomboidal tables†.

\* Vogel.

† This sublimate is composed of  $C^6 H^4 O^4$ ; or lactic acid — 2 at. water.

It is distinguished from the volatile acids by its not passing over in distillation; also chloride of iron added when the solution is supersaturated with ammonia, does not immediately yield a precipitate of oxide of iron. This last property distinguishes it from the mineral acids. The lactates are more difficultly recognized. We may conclude them to be present when the alcoholic extract, (previously supposing it to be free from salts of volatile or fatty acids) which is acid, or at least not alkaline, after incineration, and being moistened with distilled water, is distinctly alkaline (renders red litmus blue). This means can only be adopted when lactic acid is combined with fixed bases.

*Microscop. characters.*—As it ordinarily exists in the liquid state it presents no particles which can be microscopically recognized, but when crystallized it forms rhomboidal tables\*.

15. LITHATE OF AMMONIA exists in solution in all healthy urine (9.). It has been before noticed as sometimes being precipitated in health, when the quantity of water is not sufficient to retain it in solution. We now notice it as an abnormal ingredient, *i. e.* where it continues to be secreted in excess. It is the chief component of the lateritious sediments. Its colour varies from a perfect white to a beautiful pink.

*a. Chem. characters.*—It is entirely soluble in boiling water, and in 480 parts of cold, and by evaporation yields crystalline needles; also in warm dilute

\* Turner's Chemistry by Liebig and Gregory.

acids, lithic acid being precipitated ; also in solution of potash, as well as in solutions of the alkaline carbonates : it gives off ammonia when heated with potash\* ; is entirely dissipated at a red heat ; and when dissolved in dilute nitric acid and evaporated, the addition of ammonia develops murexide or purpurine. It is white when pure. The sediments containing this lithate have been divided into—1st, the yellowish or nut-brown ; 2nd, the reddish-brown or lateritious ; 3rd, the pink ; and we ought to add to these, 4th, the white ; but these discriminations are perfectly arbitrary, although convenient for reference or description ; but it may be found of every variety of colour included within the above limits. These sediments often contain lithate of soda, the crystalline form of which is represented in Pl. I. fig. 14\* ; and sometimes lithate of lime in small proportion. The nature of the colouring matter with which they are combined is also not determined ; some say the cause of the colour is the purpurate of ammonia or murexide ; others a peculiar colouring principle, purpurine.

When urine which contains lithate of ammonia in excess is boiled for some time a peculiar organic insoluble compound forms in it, the nature of which is not well known. It is quite insoluble in nitric acid. There is no albumen in the urine under these circumstances.

\* The ammoniacal fumes may be detected by,—1st, their odour ; 2nd, their forming dense white vapours when a glass rod dipped in muriatic or nitric acid is held over them ; 3rd, their rendering moistened red litmus paper blue.

*b. Microscop. characters.*—It is nearly always amorphous; I never saw more than a single natural crystalline specimen, and that I have in my possession; it is figured in Pl. I. fig. 14. The radiating needles seen upon its surface have been described as composed of superlithate of ammonia, but I have not obtained enough to enable me to speak positively on this point.

*c.* Calculi composed of lithate of ammonia are generally small, and of a clay colour, with a smooth surface; they do not possess concentric layers; they are distinguished by their chemical characters (9).

Should lithate of soda or lime be combined with the lithate of ammonia, it would not be entirely dissipated by heat, but an alkaline ash would be left: this should be dissolved in a little dilute muriatic acid. If lime be present, the addition of oxalate of ammonia would throw it down as an insoluble oxalate; if soda only, no such precipitation would occur; but by evaporation we should obtain the crystals of common salt. When heated before the blowpipe, if soda be present, it would communicate a yellowish tinge to the flame; if lime, a pale reddish purple.

16. PHOSPHATES.—In healthy urine we have present the phosphates of magnesia, lime, soda, potash, and ammonia; for the separation of these see (13. and 14.). To detect phosphoric acid in urine see (13.).

*d.* When solution of ammonia is added to urine the whole of the phosphates is precipitated; and if we examine the precipitate microscopically, we find it composed of an amorphous part,—the phosphate

of lime, and a stellar crystalline part,—the triple phosphate. When ammonia is formed slowly in the urine, as by the decomposition of its urea, the triple phosphate is produced in prismatic crystals, occasionally mixed with stellæ, but these are very few. We have then two forms of triple phosphate; a neutral—the prismatic; and a bibasic—the stellate. These are composed of\*

The prismatic or neutral,  $\begin{matrix} \ddots & & \ddots \\ \text{Ph Mg} & + & \text{Ph Az}^4 \text{H}^{12} + \text{H}^8 \text{O}^8. \end{matrix}$   $\left\{ \begin{array}{l} 2 \text{ phosphoric acid,} \\ 1 \text{ magnesia,} \\ 4 \text{ ammonia.} \end{array} \right.$

The bibasic composed of  $\begin{matrix} \ddots & & \ddots \\ \text{Ph Mg}^2 \text{Az}^4 \text{H}^{12} & + & \text{H}^{10} \text{O}^{10}. \end{matrix}$   $\left\{ \begin{array}{l} 1 \text{ phosphoric acid,} \\ 2 \text{ magnesia,} \\ 4 \text{ ammonia.} \end{array} \right.$

*b. Chem. prop.*—Triple phosphate is insoluble in water, readily soluble in dilute acids, and precipitated by excess of ammonia in the bibasic form. It is insoluble in liquor potassæ. When heated with potash the ammonia is given off; it is very difficult of fusion.

*c. Microscop. char.*—The bi- or sesqui-basic triple phosphate is composed of minute, elegant stellæ, as in Pl. I. fig. 18; it is seldom found as a natural deposit, but it may often be detected in urine which has become alkaline by keeping.

The neutral is found in the form of beautiful prisms, the most prominent varieties of which are seen in Pl. I. fig. 15. Sometimes the angles are replaced by facets. These crystals are easily recognized by their transparency, absence of colour, and peculiar forms. They are found naturally in both

\* Vigla.

acid and alkaline urine; in the cases of alkaline urine the secretion doubtless becomes so after being secreted. I do not believe urine is ever secreted as an alkaline fluid. I have imagined that the peculiar form of crystal (Pl. I. fig. 17) has generally predominated in the phosphates deposited from acid urine. Urine depositing the phosphates is usually pale in colour and low in specific gravity.

When examined by polarized light, the neutral phosphate produces the most brilliant colours, forming one of the most splendid microscopic objects. The stellar bibasic triple phosphate produces little or no effect with polarized light.

*d. Phosphate of lime.*—This is precipitated from the urine when either solution of ammonia or potassa is added to that fluid; it is then mixed with the triple phosphate of magnesia in the former case, and with the phosphate of magnesia in the latter.

*Chem. char.*—It is soluble in dilute mineral acids, and precipitated from these solutions by ammonia. When the solution in acid is nearly neutralized with ammonia and warmed, the addition of oxalate of ammonia gives a precipitate of oxalate of lime. It is exceedingly difficult of fusion. It may be separated from the triple phosphate by digestion in dilute acetic acid, which dissolves the latter, leaving most of the former\*. Dilute sulphuric acid also separates triple phosphate by dissolving it, leaving the lime as an insoluble sulphate†.

*Microscop. char.*—Generally amorphous when ex-

\* Scharling. The recently precipitated phosphate of lime is soluble in acetic acid.

† *Idem.*

isting in urine as a natural deposit, or when hastily precipitated; but found in the urine after decomposition by keeping in a crystalline state (Pl. I. fig. 18\*).

e. Urine containing excess of the phosphates is often rendered turbid by boiling, so as to resemble in that respect urine containing albumen. It has hitherto been said the addition of a drop or two of nitric acid distinguishes the two, dissolving the phosphate, and leaving the albumen. This however takes place equally in both cases, unless the quantity of albumen be very considerable. It may thus however be distinguished:—When a phosphatic cloud is produced by boiling the urine, a drop or two of nitric acid dissolves the cloud, as with albumen in small quantity, but in the former case the further addition of a few drops does not cause the precipitate to reappear, as is the case with albumen. This will distinguish the two.

The precipitate of phosphate deposited by heat is amorphous. It has been stated by a French author, that the opacity of the urine caused by heat, and not albuminous, is produced by the deposition of the subcarbonate of lime, sometimes of magnesia, deprived of the carbonic acid retaining them in solution. This has never been the case in any of the specimens I have examined. It would be readily detected by allowing the precipitate to subside, washing it, and adding a dilute acid; if it were in the state of carbonate, effervescence would take place; this would not occur if it were composed of phosphates†.

f. *Calculi composed of the phosphates.* — The

† You must not add the acid to the urine containing the precipitate after boiling without washing it; for all urines give



triple phosphate rarely composes entire calculi; nor does phosphate of lime, except in the case of prostatic calculi, which are almost entirely composed of it: the most common form is the mixture of the two, forming the fusible calculus. Triple phosphate, when heated before the blowpipe, is exceedingly difficult of fusion; the phosphate of lime is more so; the mixture of the two forms an exceedingly fusible compound, thus denominated the fusible calculus. These are usually very white and soft, often containing crystals of the neutral triple phosphate sparkling on their surface, or in their interior. The two phosphates can be thus separated. Dissolve the powdered calculus in diluted hydrochloric acid; nearly neutralize with ammonia, warm the mixture, then add solution of oxalate of ammonia, this precipitates the oxalate of lime; let this entirely subside (this subsidence often takes some time); by adding solution of ammonia in excess, we then get the bi-basic triple phosphate.

II. Constituents not existing in the healthy urine, but found normally in certain parts of the healthy body.

17. BLOOD.—The colour assumed by the secretion containing blood varies according to the quantity contained; we never see bright florid blood in this secretion; sometimes it is almost pitch-black; sometimes of the colour of Port wine; at other times the colour is only slightly deepened, the coagula

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off bubbles or effervesce under these circumstances. May not this formation of bubbles and solution of the precipitate by the addition of an acid have caused the author's error?



of fibrin lying at the bottom of the containing vessel. Occasionally the secretion is acid, but generally alkaline.

*a. Chem. char.*—When boiled the albumen is coagulated, and the venous red colour exchanged for that of chocolate; the fluid is decolorized, or nearly so, and the coagula assume the chocolate tint. Nitric acid causes a copious precipitate. It also becomes brightened in colour by the action of a strong solution of chloride of sodium, but this test is valueless compared with the former.

*b. Microscop. char.*—In some cases, where the amount is small, recourse may be advantageously had to the microscope for its detection. The blood-globules may be generally perceived, although many of them become much altered by remaining in the urine any length of time; they become granular on the surface, but however retain their characteristic yellow colour, and some of the unaltered ones may always be found with them. (See 23. *b.* and Part II. BLOOD.)

18. BILE often exists in the urine; when its passage through the biliary ducts is obstructed, it may readily be detected in this fluid. We recognize it by the free presence of its peculiar colouring matter, and the modifications this undergoes when acted upon by chemical reagents. The urine becomes of a deep reddish-brown, yellowish, or greenish tint; it stains linen yellow. Sometimes it assumes a sedimentary form, and can be separated by filtration. The colouring matter of bile is insoluble in water and alcohol, but readily soluble in caustic potash.

When muriatic acid is added to urine containing bile it becomes green; nitric acid produces first a green, then a brownish, and lastly a reddish tinge. (See Part II. BILE.)

19. ALBUMEN.—The urine very frequently contains this principle; sometimes it appears for a time and then disappears entirely; at others it remains constantly present. The secretion, when it occurs, generally contains a very considerable amount of epithelial scales, and a number of granules or globules, not unlike those of pus.

*Chem. char.*—It may readily be detected by boiling the urine, when it falls as an opaque white cloud; sometimes merely an opacity is produced, at others the urine becomes almost solid. As the phosphates when in excess are precipitated by heat, we must make use of a reagent to be sure we are correct in determining its presence. It has, I think, been quite overlooked by chemists, that albumen is redissolved by nitric acid much in the same manner as the phosphates, but such is the case; and when the quantity of albumen present is small, the appearances presented by the two are not very dissimilar. They cannot be mistaken however if attention be paid to the following circumstances. A deposit of albumen by heat (when not very abundant) is redissolved by a drop or two of nitric acid; so is the phosphatic cloud; on continuing to add more nitric acid to each, the albumen reappears; not so with the phosphates, they are permanently dissolved; moreover, a very minute quantity of acid will dissolve the phosphates, much less than is required to dissolve the albumen.

You must by no means trust to solution of alum or bichloride of mercury, as has been recommended, for these reagents precipitate nearly all urines, and although the appearances produced by their effects are different from those where albumen is present, as they are liable to fallacy they should be avoided. The most delicate test of albumen is the formation of a precipitate by the ferrocyanide of potassium after the addition of a few drops of acetic acid\*. It is not precipitated by heat when excess of free or carbonated alkali is present, or when a large quantity of acetic or phosphoric acid is present.

Another substance has been noticed† as occurring in the urine under certain circumstances, which might by a very careless observer be mistaken for albumen, inasmuch as it is precipitated by the addition of nitric acid. It is not however thrown down by heat, and thus it is not very likely to be mistaken; moreover, the peculiar odour communicated to the urine under these circumstances would apprize us of its probable existence,—I allude to a peculiar resinous compound found in the urine of those patients under the influence of copaiba. I must also merely mention here, although it is not likely to be made use of as a test, that the phænomena of circular polarization of light can be developed in albuminous urine.

Albuminous urine is generally most loaded after the completion of digestion. Very low in sp. gr. ;

\* This cannot be depended upon alone, for the other protein compounds, fibrin and casein, as well as gelatin, are also precipitated by this reagent.

† Dr. Rees, Medical Gazette, December 1840.

sometimes however in recent cases, and where it is combined with high fever and suppression of the cutaneous function, it becomes very high in sp. gr., and loaded with lithates and urea. In these cases, upon heating the urine, the lithates are first dissolved, and then upon the continuance of the heat the albuminous cloud appears. It is usually deficient in the ordinary amount of urea and lithic acid. The fluid has also a dull muddy aspect, which is considered by some persons as almost diagnostic. In those cases of albuminous urine arising from other causes than granular kidney, the mucous globules and epithelial scales are usually much less numerous than in the confirmed organic disease.

*Microscop. char.*—An amorphous, granular-looking cloud, or precipitate. This urine invariably contains a number of globules, not unlike those of pus, as well as a large number of epithelial scales.

20. OLEO-ALBUMINOUS URINE is not by any means common. It was first accurately described by Dr. Prout, and was called by him chylous urine, inasmuch as he considered it to owe its peculiarities to chyle passing into the blood without undergoing further elaboration, and being discharged, like other foreign matters, from the circulation by the kidneys. It resembles milk in colour and consistence. It is commonly acid, and decomposes more readily than natural urine. By standing it sometimes coagulates, sometimes continues homogeneous. It is coagulated by heat, and when acidulated with acetic acid, yields a precipitate to ferrocyanide of potassium. It contains fatty matter, which can be

separated by agitation with æther. [For a minute account of the properties of chyle *vide* Part II. CHYLE.]

21. A SIMPLE OLEAGINOUS OR FATTY MATTER has been occasionally found in the urine, forming a pellicle or scum on it a short time after having been passed. This has been supposed to arise from steatomatous tumours adhering to the inside of the bladder. It is rare, and has doubtless in some cases been added for the sake of imposition on the part of the patient. It would be readily distinguished by its peculiar appearance, the large size of the oil-globules, and the absence of all milkiness or opacity.

22. SEMEN.—When this is present in urine the mucous cloud is increased and is more dense. The urine becomes very slightly albuminous\*, and by decanting the fluid part of the urine, and examining the sediment under the high powers of a microscope, the spermatic animalcules may be perceived (Pl. II. fig. 33). *Vide* SEMEN, Part II.

III. 23. Principles occasionally found in the urine, but never existing in that fluid in health, nor in other fluids of the healthy body.

*a.* Various abnormal and remarkable colouring matters have been occasionally found in the urine, sometimes forming a deposit, sometimes in solution. Blood has been noticed (17.). Prussian blue (sesquicyanide of iron) and indigo have both been detected. Indigo would be distinguished by washing the sediment composed of it well with water, and drying it, when by heating it to between 500° and 600° it

\* Becquerel.

would be sublimed in acicular crystals. Prussian blue would be readily recognized by boiling it in solution of potash, when, upon the subsequent addition of a solution of perchloride of iron, the blue colouring reappears; this is not the case with indigo.

*b.* A blue colouring principle termed cyanourine has been also found in the urine. This is turned red by acids, and on neutralizing the acid by an alkali the original blue tint is restored. Caustic potash has little or no effect on it\*. Various articles taken into the stomach alter the colour of the urine, such as madder, beet-root, rhubarb, &c. In some cases the red colour produced by some of these has been mistaken for blood. They would be readily distinguished by the absence of the peculiar effects of boiling (17.); in these cases the colour is not destroyed by heat; moreover, by adding liquor potassæ to such urine, a green colour is produced; this is destroyed on neutralizing the alkali by an acid, and the original tint reappears.

*c.* The various shades of colour produced when the urine is loaded with the lithates have already been noticed (15*a.*); sometimes the quantity of colouring matter combined with the lithate of ammonia is so great as to make the urine appear almost black. A peculiar black substance has also been noticed, which became developed after the urine had been passed, and has been denominated melanic acid; but it is so rare as hardly to require mention.

24. Many dietetic articles also impregnate the urine with their odoriferous principles; some of these

\* Braconnot.

become altered in their passage through the system. Essential oils, balsams, onions, asparagus, coffee, &c. can be detected in this manner. The ready communication of the odoriferous particles of food to the urine would indicate mal-assimilation. Oil of turpentine communicates a powerful odour of violets to this secretion.

25. Salts in passing through the system are in some cases decomposed, in others they remain unchanged. Thus the tartrate, citrate, and acetate of soda or potash become converted into carbonates. The vegetable acids appear united with bases; whilst the mineral salts pass through the system, and appear in the urine unchanged.

Iodine, taken internally, appears in the urine as an iodide or an iodate\*, and may be readily detected thus:—Add to the secretion a few drops of nitromuriatic acid, or a solution of chlorine, and then a cold solution of starch; the blue iodide of starch immediately appears. In some cases it is requisite to evaporate the urine to dryness, then to boil water on the residue; this solution, tested in the same manner, produced the same effects.

Quinine and mercury are said also to have been found in the urine.

26. HIPPURIC or URO-BENZOIC ACID appears in the urine when benzoic acid has been taken internally; it never exists in the healthy secretion. It is obtained on concentrating the urine by slow evapo-

\* Generally, if not always, as the latter; inasmuch as on boiling alcohol on the residue of evaporation the iodine is not removed.



ration, and then adding muriatic acid, when it is precipitated in the crystalline form (Pl. II. fig. 40).

I have never been able to detect hippuric acid in the urine of children, although it is stated to exist there. I fear there is some mistake in this matter.

*Chem. char.*—Uro-benzoic acid is soluble in 400 parts of cold, and in a small quantity of boiling water; soluble in alcohol, sparingly soluble in æther; dissolves without change in muriatic acid. Nitric acid converts it into benzoic acid.

It is composed of C 18, N, H 9, O 6.

*Microscop. char.*—The crystals are long four-sided prisms, whose modifications are seen in Pl. II. fig. 40.

It may be distinguished from benzoic acid by its crystalline form. The latter crystallizes in aggregated hexagonal needles or pearly scales, and is soluble in 2 parts of sulphuric æther, whereas hippuric acid crystallizes in isolated four-sided prisms, and is very little soluble in æther.

27. NITRIC ACID has been sometimes detected in the urine, and its action upon the lithic acid has been supposed to be the cause of the production of the purpurate of ammonia or murexide, which colours the beautiful pink deposits. It would be best thus detected:—Neutralize any free acid by potash; evaporate to dryness; dissolve the residue in a small quantity of water; add a little sulphuric acid, and then a green crystal of protosulphate of iron. If nitric acid be present, it will be decomposed, and the resulting nitric oxide passing through the water containing the protosulphate in solution will cause the



formation of a black deposit or cloud around the crystal.

28. OXALIC ACID when added to urine forms an insoluble oxalate of lime, so that should it be present at any time it would unite with the lime always existing in urine, and form an insoluble compound. Should it be suspected to exist free, or as a soluble oxalate, it might be detected thus:—Add a solution of chloride of calcium to the suspected urine or solution; if oxalic acid be present, an insoluble precipitate would be formed; this would be distinguished from the sulphate of lime by its solubility in nitric acid, and from the phosphate or tartrate, &c. by its insolubility in a small quantity of hydrochloric acid, which these are; it is, however, soluble in considerable excess. Wöhler has observed oxalate of lime in the urine after oxalic acid had been taken internally, and Donné has observed that after eating sorrel the urine has become filled with crystals of the same compound.

29. OXALATE OF LIME.—This in the form of a crystalline deposit is not nearly so rare as was formerly supposed\*; it is often combined with the lithates.

*a. Chem. char.*—Insoluble in liquor potassæ, also in acetic acid. When incinerated, carbonated and caustic lime are left. By boiling with excess of sulphuric acid the oxalic acid may be separated and recognized by its peculiar character, which is the formation of a white precipitate, soluble in nitric, but not in a small quantity of muriatic acid (28.).

By boiling oxalate of lime in solution of carbonate

\* This was first pointed out by Dr. Golding Bird.

of potassa double decomposition takes place, carbonate of lime is precipitated, and oxalate of potassa remains in solution.

*b. Microscop. char.*—When present in the urine it occurs in crystals, whose form is a very flat octahedron. As they lie upon the field of the microscope they appear to have a rectangular, or sometimes a square outline. When dry they appear to have a smaller square placed within the larger, whose sides are opposite the angles of the latter; this arises from the lateral rays being refracted beyond or without the field of the microscope (Pl. II. fig. 22). When moist they appear as in Pl. II. fig. 21. But their true form can only be shown by placing them, when gently moistened in æther or spirit, and then examining them under the microscope. Sometimes they appear in the form of what Dr. Bird has called dumb-bells (Pl. II. figs. 24, 25), or sometimes a modification of them, which I have found, as in Pl. II. fig. 24\*. By polarized light the dumb-bells give the most splendid colours; whilst the octahedrons produce very little, sometimes no alteration.

*c.* Urine containing oxalate of lime is extremely various in its characters; sometimes it is very pale, at others loaded with lithates, and high-coloured.

*d.* Calculi composed of oxalate of lime, or mulberry calculi, are invariably tubercular upon the surface, of a grayish-brown tint, very hard and dense; sometimes the surface is covered with sparkling crystals of the same composition. When urate and oxalate of lime are combined, they may be conveniently separated by digesting the powdered calculus in a

large proportion of dilute hydrochloric acid, which dissolves the oxalate alone and unchanged; the lithic acid is precipitated, whilst the lime with which it was united combines with the excess of hydrochloric acid. The liquid must be filtered to get rid of the lithic acid, and by saturating the clear fluid with ammonia, oxalate of lime is precipitated. The remainder of the lime resulting from the decomposed urate will subside on adding oxalate of ammonia\*. Before the blowpipe oxalate of lime chars, and on continuing the heat a white ash is left; this is alkaline, and effervesces with acids. It may be shown to be lime by dissolving in a small quantity of dilute muriatic acid, and adding solution of oxalate of ammonia, when the insoluble oxalate is thrown down.

30. CARBONATE OF LIME sometimes occurs as a urinary deposit, always however as a secondary production, being formed from the decomposition of the calcareous salts by the carbonate of ammonia resulting from the decomposed urea. A small quantity is occasionally found in urine loaded with phosphates; it is also found in calculi, chiefly mixed with other ingredients. It would be readily distinguished by its solubility with effervescence in dilute muriatic acid, the solution being precipitated by oxalate of ammonia. It has been said to be the cause of the precipitate formed in urine by heat not albuminous; this, however, I believe to be incorrect. *Vide* (16 c.)

31. CYSTIC OXIDE is of exceedingly rare occurrence, but is sometimes found as a urinary deposit, sometimes as a calculus.

\* Scharling.

*a. Chem. char.*—It is soluble in dilute nitric, sulphuric, muriatic, oxalic, and phosphoric acids; and is insoluble in acetic, citric, and tartaric acids and alcohol; also soluble in ammonia and the caustic alkalies, and in the fixed alkaline carbonates; but not in the carbonate of ammonia. It is entirely dissipated by heat, giving off a characteristic odour. It is nearly insoluble in water. By the spontaneous evaporation of its ammoniacal solution it may be obtained in crystals.

Composition,  $C_6 H_6 N S_2 O_4$ .

*b. Microscop. char.*—Cystine generally crystallizes in delicate six-sided plates, sometimes in quadrilateral plates; sometimes the crystals are crenate at the margin, with a dark nucleus; and often we can perceive irregular laminae on their surface.

Their effect with polarized light is very various; sometimes we have colour developed, but often none.

*c.* Urine containing cystine has a greenish tinge, and an odour of sweet-briar. In putrefying this urine exhales sulphuretted hydrogen. Cystine is precipitated from urine by the addition of acetic acid.

*d.* Calculi composed of cystine are generally covered with smooth tubercles, and have a waxy appearance. When recent they are brown, but become gray or green by keeping. They have no concentric layers.

32. Pus is occasionally present in urine. When in large quantity and unaccompanied by mucus, or when mixed with blood, it may generally be supposed to be derived from an abscess; but when mucus is

in excess, or has preceded the pus, most probably it is derived from the urinary mucous membrane. When present in urine it renders that fluid albuminous, and gives a yellowish or greenish tinge to the sediment which it composes; it can easily be diffused through the urine by agitation, and would be readily distinguished from mucus by its want of tenacity or viscosity, and by the large number of globules which float in its albuminous liquid. Urine containing pus has little tendency to putrefy. When pus is acted upon by ammonia it becomes converted into a viscous gelatinous mass, which depends upon the union of the ammonia with the fatty matter of the pus.

*Microscop. char.*—The peculiar globular granular particles can be readily perceived by a good microscope; they are several times larger than those of the blood, almost colourless; these characters would distinguish them when in small quantity from those of blood, which are entire, smooth, yellow, and flattened. When acted upon by acetic acid they leave distinct nuclei, which vary in number. *Vide* Part II. BLOOD and PUS.

33. SUGAR.—The presence of sugar in the urine properly characterizes diabetes. The quantity of urine sometimes passed in this disease is almost incredible. It is usually pale in colour, higher sp. gr. than 1030, of a hay-like smell. If left in a warm place it becomes covered with a frothy white layer, as if its surface had been sprinkled with flour. This is quite characteristic, and when once seen cannot be mistaken. This white froth is composed of a number

of minute vegetable organizations which have been denominated *Torulæ*; they occur in all fermenting liquids, and their growth is by some considered in relation to fermentation in the light of cause and effect\*. They are figured in Pl. II. fig. 35: their development is very interesting. When first formed they are very minute spherical globules composed of two coats, and filled with a liquid containing in suspension a number of extremely minute granules; the globules enlarge, rise to the surface, and form the white scum. Some of the internal granules also enlarge, and become distinct nuclei. These continue expanding, the primary globule becomes elongated, and one of the enlarged nuclei bursts through the envelopes of the maternal cell and appears as a bud; this enlarges, others increase in the same manner. As the globules enlarge they become elongated, finally forming long, slender, jointed vegetables, as in Pl. II. fig. 35. These contain several nuclei which are ready to bud out in the same manner as their parents have originally done. They seem to increase in two distinct ways; one is the budding process above mentioned, the other is the division of the parent cell. It is first divided by the increase of two, three or more nuclei into as many separate parts. It then becomes contracted opposite the spaces between the continuous extremities of the internal young cells, finally forming distinct and independent plants, capable of further propagation in a similar manner.

The quantity of urea present in diabetic urine was

\* Turpin.



at one time considered to be less than natural, but this has since been proved to be incorrect by the experiments of Mr. MacGregor\*. The mode of detecting it is described at (11 *d.*). The amount of sugar may be estimated by fermentation (*id.*); each cubic inch of carbonic acid gas produced corresponding to nearly one grain of sugar. It is almost impossible to separate the whole of the urea from the sugar and other animal matters. The sugar in a quantitative analysis is most easily estimated in combination with the lactates and other animal matters (14.).

Crystalline sugar can be thus obtained from diabetic urine:—Add to it solution of diacetate of lead; filter; throw down the lead by sulphuretted hydrogen; filter again, and evaporate to a syrup; by boiling alcohol on this, and allowing it to evaporate spontaneously, crystals will be produced. In many cases it may be obtained merely by evaporating to dryness, &c. without using the acetate of lead. It is composed of C 12, H 14, O 14. When heated with nitric acid oxalic acid is formed; this may be recognized by its appropriate tests (28.).

Diabetic sugar is identical in composition with that of grapes. Its crystalline form is represented in Pl. II. fig. 36.

It is readily soluble in water and a mixture of alcohol and water, but little or not at all in absolute alcohol and æther.

The quantity of solids in 1000 parts of diabetic

\* MacGregor, Experimental Inquiry.

urine of different specific gravities may be readily found from the following Table.

Sp. gr. at 50° F.	Solids.	Sp. gr. at 50° F.	Solids.
1031	51·15	1041	67·65
1032	52·80	1042	69·30
1033	54·35	1043	71·05
1034	56·00	1044	72·70
1035	57·65	1045	74·45
1036	59·30	1046	76·10
1037	60·95	1047	77·75
1038	62·60	1048	79·40
1039	64·35	1049	81·55
1040	66·00	1050	83·20*

The phænomena of circular polarization of light are developed in diabetic as well as in albuminous urine.

34. Milk has occasionally been found in the urine; but I believe in all cases it has been purposely put into it. Urine under these circumstances is coagulated by acetic acid, but not by boiling. But by the peculiar globules which would be found in it, we should readily recognize the imposition. (Pl. II. fig. 32. *Vide* Part II. MILK.)

35. XANTHIC OXIDE is of extremely rare occurrence. It is, I think, mostly considered as doubtfully existing as a body *sui generis*. It would be distinguished by its dissolving without effervescence in nitric acid, and its leaving a yellow residue on evaporation, not pink, as in lithic acid (12 *a.*). It cannot be crystallized. It is precipitated from its solution in potassa on the addition of hydrochlorate of ammonia; this is not the case with lithic acid.

\* Simon.



36. Calculi have been found composed entirely of animal matter. Their chemical characters resemble those of fibrin, and they are therefore called fibrinous calculi. They resemble yellow wax in colour and consistence.

*Chem. char.*—Insoluble in water, alcohol, and hydrochloric acid. Soluble in caustic potash, and precipitated by muriatic acid. Soluble in acetic acid by heat, and this solution is precipitated by ferrocyanide of potassium. By the blowpipe they give out a smell of burnt horn, and leave a bulky charcoal.

Composition,  $C_5 + N_2 + O_2 + H_2$ .

37. After the urine has escaped from the bladder decomposition soon commences; this it has been previously mentioned appears to be hastened by the presence of the mucus, as it may be preserved from decomposition for a greater space of time when this is removed. In warm weather a urine loaded with urea will become neutral and even alkaline in a few hours. This process is also much hastened when the mucus is in excess; these urines, if not alkaline at the time of passage from the bladder, very speedily become so. The first and most important change noticed is the decomposition of the urea; by uniting with the elements of the water present, it becomes converted into carbonate of ammonia; a portion of the carbonic acid of this escapes; the ammonia unites with the phosphate of magnesia, forming the triple salt. This is always present in a crystalline form in stale urine, adhering to the sides of the containing vessel. The phosphate of lime is partly

precipitated in an amorphous form, and a portion of carbonate of lime is also formed. The urine often becomes much deepened in colour, and gradually opaque throughout. A scum invariably forms upon its surface, composed of a peculiar magma of animal matter\*, covered with crystals of triple phosphate. It will be readily perceived from the above account how important it is to obtain the urine fresh and examine it at once; otherwise the patient may be treated as suffering from a phosphatic deposition, which is the consequence of decomposition only.

38. The early formation of a peculiar scum on the surface of urine has been adverted to as a sign of pregnancy. It has been observed by many that an opaque greasy-looking layer begins to form in the urine of pregnant women soon after it is passed; this often takes place whilst the urine is still acid, but it very soon after becomes neutral, and then alkaline. As soon as the urine has become neutral this crust becomes covered with crystals of the neutral triple phosphate. This layer or scum has been denominated Kiestein. When it is acted upon by acetic acid the phosphatic crystals are dissolved, and the animal matter is left; when acted upon by ammonia the animal matter is dissolved, and the crystals remain. To observe this appearance, about four or six ounces of perfectly fresh urine should be laid aside in a tall, moderately narrow glass vessel, and a paper cover laid over it, to exclude dust. It should then be placed in a tolerably warm atmosphere. The ap-

\* Consisting of very minute granular particles.

pearanee denominated kiestein would be produced should a crust similar to that above described appear within a day or two. The crust I spoke of formerly as occurring in all urine could hardly be confounded with this, as it appears so much later in the urine. When examined microscopically the crust of kiestein appears composed of very minute globules. When it has remained on the surface of the urine for a few days (this fluid often exhaling a peculiar cheesy odour) it breaks up and falls to the bottom.

It has been stated that the quantity of the salts of lime in the urine of pregnancy is much diminished. I have examined a very large number of urines of women during pregnancy, but I have not found this by any means correct. With the exception of the peculiar fermentation (?) which produces the kiestein, and the peculiar cheese-like odour, there are no characteristics of the urine in pregnancy, and even these are not constant.

39. In many urines, particularly those which have contained considerable excess of lithate of ammonia by being kept, a number of minute blackish globules appear. I have seen these in urine several times, but unfortunately have not recorded the effects of chemical reagents upon them to determine their nature. I satisfied myself that they were not lithate of ammonia, but I can say nothing more from my own experience. They are sketched from a preparation in my possession (Pl. II. fig. 34). The urine in these cases had assumed the peculiar deep brownish-red colour it generally does by keeping.

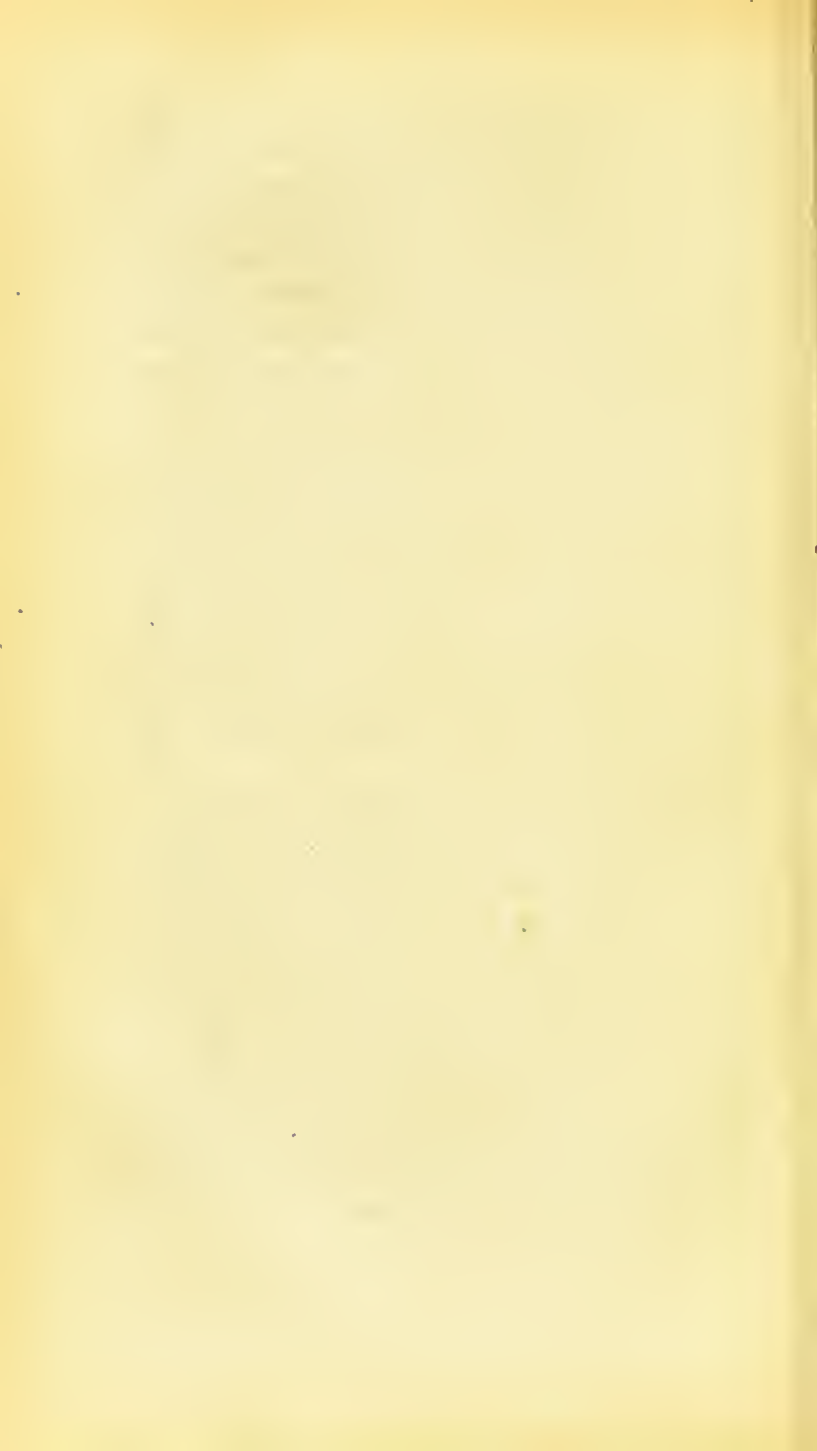
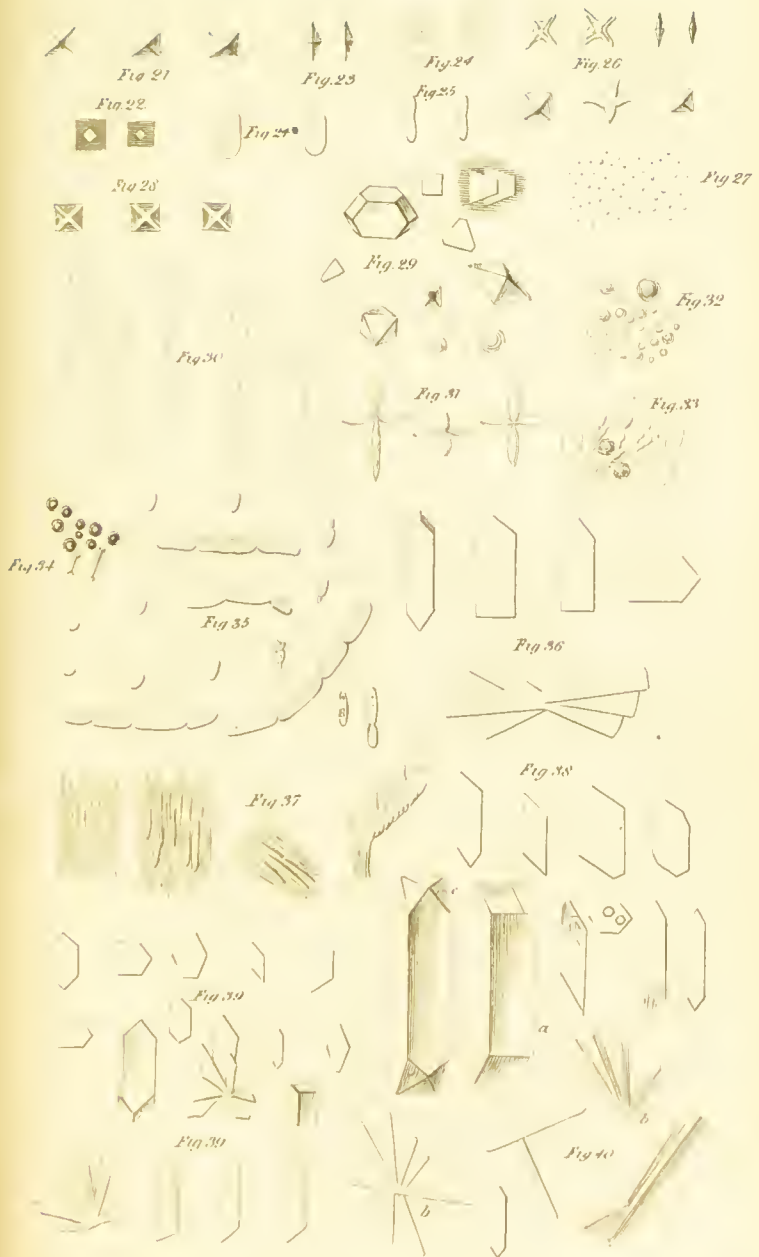




Plate I



# Plate II







## DESCRIPTION OF THE PLATES.

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THE sketches are all made from preserved specimens in my own possession, except when otherwise mentioned. The most common and most readily distinguished forms only are sketched, except where there are some peculiarly interesting features in others. I may say the varieties of form assumed by these crystalline deposits are almost endless.

### PLATE I.

#### *Forms of Lithic Acid.*

- Fig. 1. Form of the crystals of lithic acid as obtained by adding a few drops of an acid to urine. They possess a curious hour-glass internal structure; and their extremities are not entire, but composed of small crystalline needles. The rhomboidal form, when viewed at the extremities, is represented in *a*. Magnified 90 diameters.
2. Ordinary form of lithic acid when occurring naturally as a crystalline sediment. Internal nuclei are here apparent, and in some cases one or both the apices are prolonged into a beak-like form. 90 diameters.
  3. Same deposit; here the obtuse angles are replaced by semicircular facets; side view. 90 diameters.
  4. Same, lying on its face. 90 diameters.
  5. The forms represented here are such as are obtained in precipitating a boiled solution of lithic acid or lithate of ammonia in solution of potash by an acid; this is very pure and colourless; and the internal structure is beautifully developed by polarized light. 150 diameters.

Fig. 6. A modification of the same.

7. A natural form of lithic acid, frequently mistaken for the cubic. They are curiously nucleated, but their rhomboidal forms can be readily detected by examining them in a watch-glass with æther, &c. 90 diameters.
8. Aggregation of lithic acid prisms. 90 diameters, natural.
9. Foliateous crystalline forms of lithic acid, sometimes occurring in urine with the regular ordinary rhomboids. In some cases they appear tied round the centre as with a string. 90 diameters.
10. Curiously nucleated form of lithic acid, the nucleus retaining the rhomboidal outline. 90 diameters.
11. The same as fig. 3, and having a rectangular nucleus.
12. Modification of fig. 9.
13. Prismatic forms of lithic acid. Here the rhombic prism is elongated, so that these crystals always present a rectangular outline. The true form is discovered by moistening with æther, &c. The rhomboidal outline may often be detected on their extremities, as in  $\alpha$ , and they are often beautifully striated transversely, as in  $\beta$ . 90 diameters.
14. Lithate of ammonia in the globular form; the needles are most probably in the state of superlithate; minute rhomboids of lithic acid mixed with it, and probably resulting from its partial decomposition. Very rare. 300 diameters.
- 14\*. This is the form of lithate of soda. I have twice met with it, it approaches very near to my form of lithate of ammonia (fig. 14.), but is distinguished by the needles in the former being acute at the extremities, and in the latter obtuse.

*Forms of Phosphates.*

- Fig. 15. Various forms assumed by the neutral triple phosphate. A trilateral prism with truncated summits appears to be the predominating form. In some cases, one or two, and in others all the angles are replaced by facets. 90 diameters.
16. The same composed of aggregated prisms. This is by no means a common form. 300 diameters.
17. The form of neutral triple phosphate generally found when the urine containing it is acid. 90 diameters.
18. Forms of bi- or sometimes called sesqui-basic triple phosphate. 600 diameters.
- 18\*. Phosphate of lime after Simon †.

*Forms of Cystine.*

19. These crystals are remarkable for their regular six-sided form (*a.*), always having traces of laminæ on their surface (*a\**). In some cases their centres are occupied by black masses, as in *b.* Sometimes the whole crystal assumes this form. It then appears composed of an aggregate of minute needles. 90 diameters.
20. Cystine assuming the form of the rectangle. The effect of polarized light upon this is much more striking than upon the six-sided form. In some rare cases the cystine has assumed the form of a semicircular plate, showing beautifully the black cross when examined by polarized light.

## PLATE II.

*Forms of Oxalate of Lime.*

21. Ordinary form when moist. The outline appears rectangular or square. 300 diameters. Natural.

† I have specimens of this.

Fig. 22. The same when dry.

23. The same viewed edgewise, as seen rolling over in spirit or æther.
24. Dumb-bell form of oxalate. 600 diameters. Natural.
25. The same lying on its side. These appear composed of very minute needles.
26. Represents the oxalate as precipitated from urine by oxalic acid or oxalate of ammonia. 300 diameters.
27. The same, only exceedingly small.

28, 29, 30, 31. *Crystals of Chloride of Sodium.*

28. Crystallized from distilled water. We have here a peculiar appearance which might very readily be mistaken for that of an octahedron.
29. Slowly crystallized from urine. We have here forms somewhat resembling those of oxalate of lime and cystine; but there are no laminæ to the hexagonal plates, as in cystine; nor are the sides equal, as in the latter; and the octahedron is not flattened, as in oxalate of lime. Moreover, the solubility of chloride of sodium in water would at once distinguish it from these two.

The figures 30 and 31 are formed when common salt is crystallized rapidly from urine or a solution of urea. They appear generally crenate at the margin, sometimes however quite entire, and of the form of a dagger. 90 diameters.

32. Globules of milk, characterized by their extreme variations in size, absence of nucleus, and spherical smooth surface. It appears to me quite absurd to talk of the "size" of milk-globules as definite, for they are of almost all sizes. 300 diameters.
33. Spermatic animaleules, with epithelial scales and

mucus globules\*, found in urine containing semen. 300 diameters.

Fig. 34. Black globules found in urine by keeping, mixed with crystals of triple phosphate.

35. "*Torula Diabetica*." I do not know of any characters by which this fungus can be distinguished from that found in milk or other saccharine liquids; in fact, I believe they are all the same. 300 diameters.

36. Crystals of diabetic sugar. 90 diameters.

37. Crystals of nitrate of urea. Impure, as ordinarily obtained by adding nitric acid to concentrated urine, or that containing urea in excess. 90 diameters.

38. The same in a more pure and distinctly crystalline form. 90 diameters.

39. Crystals of oxalate of urea. 90 diameters.

40. Crystals of hippuric acid. 90 diameters.

c. Perfect form (Ure).

a, b, b. Crystallized from alcohol.

Some of these forms are not unlike those of nitrate and oxalate of urea, but the peculiar circumstances under which they are produced would readily distinguish them.

\* From the prostate ?

THE END.





